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CPW-fed Monopole Antenna with L shaped and stair shape slot for Dual-band WLAN/WiMAX Applications

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Abstract :

A novel dual-band design of a finite ground coplanar waveguide (CPW)-fed monopole antenna is presented for simultaneously satisfying wireless local area network (WLAN) and worldwide interoperability for Microwave Access (WiMAX) applications. The wireless communication industry is integrating a number of services like Bluetooth, WLAN etc to the hand held communication devices. Therefore, in the present scenario, the bandwidth requirement of the antenna while maintaining the compactness becomes more critical.

The proposed antenna, comprising a rectangular planar patch element embedded with two L shaped slots and stair shape slot in the middle of the patch element. The simulated -10 dB bandwidth for return loss is from 2.0 to 2.2 GHz and 2.8 to3.1 GHz, covering some of the WiMAX and WLAN bands. Prototypes of the obtained optimized antenna have been designed and constructed. The Antenna has 9.5 % (-10 dB return loss) band width ranging from 2 to 2.2 GHz, and -21 dB return loss is from 2.85 to 2.95 GHz.The parametric study is performed to understand the characteristics of the proposed antenna. Also, good antenna performances such as radiation patterns and antenna gains over the operating bands have been observed and VSWR is 5.2 at 2.4 GHz. The radiation patterns in polar plot theta 90& 150 degrees.

Key Terms :

Dual-band antennas, Monopole antennas,WiMAX and WLAN,VNA

I. Introduction

Multiband printed monopole antennas have aroused widespread applications, especially in low power wireless communication gadgets. In the era of modern wireless communication systems,dual-band or multiband antennas with omni-directional radiation characteristics play a vital role [1, 2]. Advances in wireless communication technologies are placing greater demands on higher antenna impedance bandwidth and smaller antenna size.

The design of broadband antennas has received the attention of many antenna researchers due to their various applications [3]. The currently popular designs suitable for WLAN operation in the 2.4 GHz (2.4–2.484 GHz) and 5.2/5.8 GHz (5.15–5.35 GHz/5.725–5.825GHz) bands and WiMAX operation in the 2.5/3.5/5.5 GHz bands have been reported in [1-6]. The planar monopole antenna has received much more interest than others, due to its potential in providing the various radiation features required for dual-band or multi-band, wide bandwidth, low profile communication systems. However, these kinds of antennas mostly need a large ground plane, which is often printed on the opposite side of the substrate from the radiating plane.

Thus a via-hole connection is always necessary for feeding the signal, and this increases the manufacturing difficulty and cost. Recently, the coplanar waveguide (CPW)-fed monopole antenna has become very popular in WLAN and WiMAX systems, owing to its many attractive features such as, wider bandwidth, low radiation loss, a simple structure of a single metallic layer and easy integration with WLAN integrated circuits [8].a proposed antenna design with CPW-feed technology has been used to achieve dual-band operation for both WLAN and WiMAX bands[9-10]. The proposed dual band antenna consists of a rectangular shaped patch element embedded with two L shaped slots and stair-shape slot in the middle of the patch element, capable of generating two separate bands with good impedance matching conditions. This way, the antenna can achieve a dual-band performance to simultaneously cover the most commonly used 5.2 GHz WLAN and 3.5 GHz WiMAX bands. Details of the proposed antenna design are described in the paper, and simulated results are presented and discussed in the following sections.

II. Material and Methodology

Fig.1 shows the geometry of the proposed finite ground Coplanar waveguide (CPW) fed dual-band monopole antenna. Original name for coplanar waveguide was planar strip line The advantages of coplanar waveguide are that active devices can be mounted on top of the circuit, like on micro strip. More importantly, it can provide extremely high frequency response (100 GHz or more) since connecting to CPW does not entail any parasitic discontinuities in the ground plane.

The proposed antenna was fabricated on FR4 substrate with dielectric constant 4.4 and thickness 1.6 mm. The basis of the antenna structure is chosen to be a rectangular patch element with dimensions of width W and length L, and with a vertical spacing of'd' away from the ground plane. A conventional CPWfed line designed with a fixed signal strip thickness Wf and a gap distance of 'g' between the signal strip and the coplanar ground plane is used for exciting the radiating patch element. Two finite ground planes with the same size of width Wg and length Lg, are situated symmetrically on each side of the CPW feeding line.

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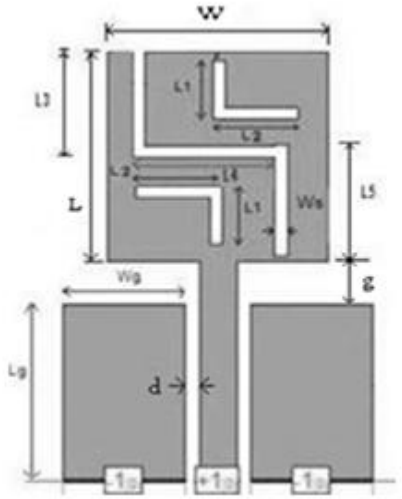

Fig1:Geometry of proposed antenna

The final optimized dimensions of proposed antenna are: length of the rectangular patch L=19.3mm, width of the rectangular patch W=19.27mm, width of ground plane Wg=10.2 mm, length of ground plane Lg=16.2 mm. Slot length are: L1=5.7mm,L2=7.5mm, L3=10.2mm, L4=14.6 mm, L5=9.41mm and having slot width of Ws=1mm. The space between the rectangular patch and ground plane g=3mm and the feed line width of the feeding port is Wf = 3mm and vertical spacing between feed-line and ground plane d=1mm.
The optimum parameters are obtained with the aid of Ansoft HFSSv12 software. Total volume of the proposed antenna is 0.6 cm3. Photograph of the fabricated prototype is shown in Fig.2.

III. Results

The simulated parametric study results and return losses for the proposed monopole antenna are obtained. The simulated return losses are presented for the optimized set of antenna parameters in Fig.3.The simulated impedance bandwidth of the proposed antenna covers two impedance bandwidths, 2 to 2.2 GHz as the lower band,and -21 dB return loss is from 2.85 to 2.95 GHz as the upper band respectively.
SIMULATED RESULTS:
The proposed antenna is simulated in Ansoft HFSS v12 software and the results obtained are shown below.

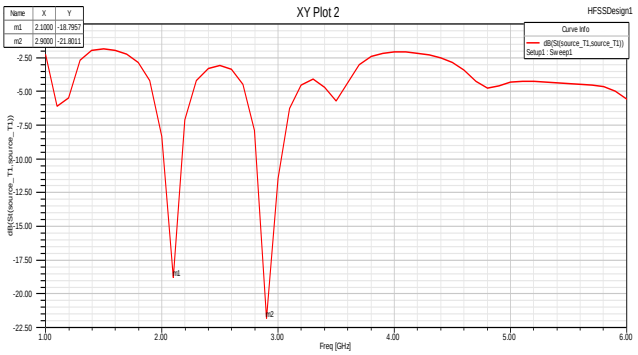

Fig.2:Simulated Return loss characteristics(in Ansoft HFSSv12)

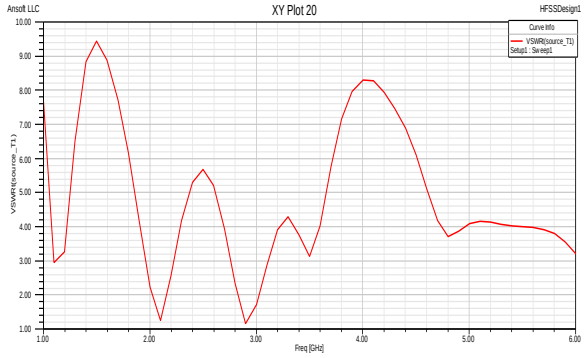

Fig3: Simulated VSWR characteristics

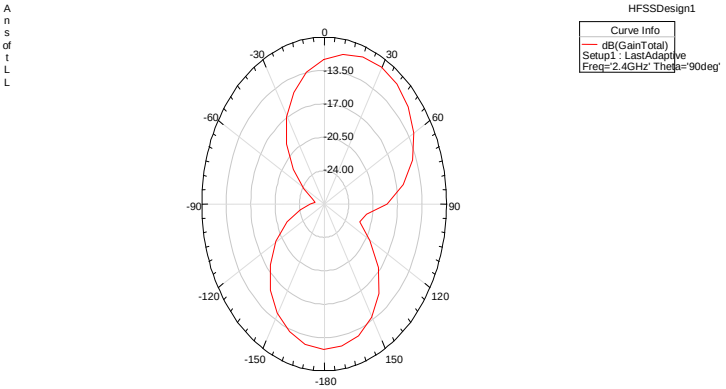

Fig4: DB GAIN VS Phi (theta=90 deg)

IV. Conclusion

A dual-band monopole antenna covering WiMAX and WLAN bands is proposed. The various parameters of the proposed antenna are optimized through simulation. Prototype of the proposed antenna has been designed, simulated in Ansoft HFSSv12 software and the fabricated
Antenna is tested using Vector Network Analyzer (VNA).
We may observe the practical return loss bandwidths in Vector Network Analyzer also, after fabrication. The proposed antenna provides nearly Omni-directional radiation characteristics with moderate gain and efficiency which is suitable for the next generation wireless communication gadgets.

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